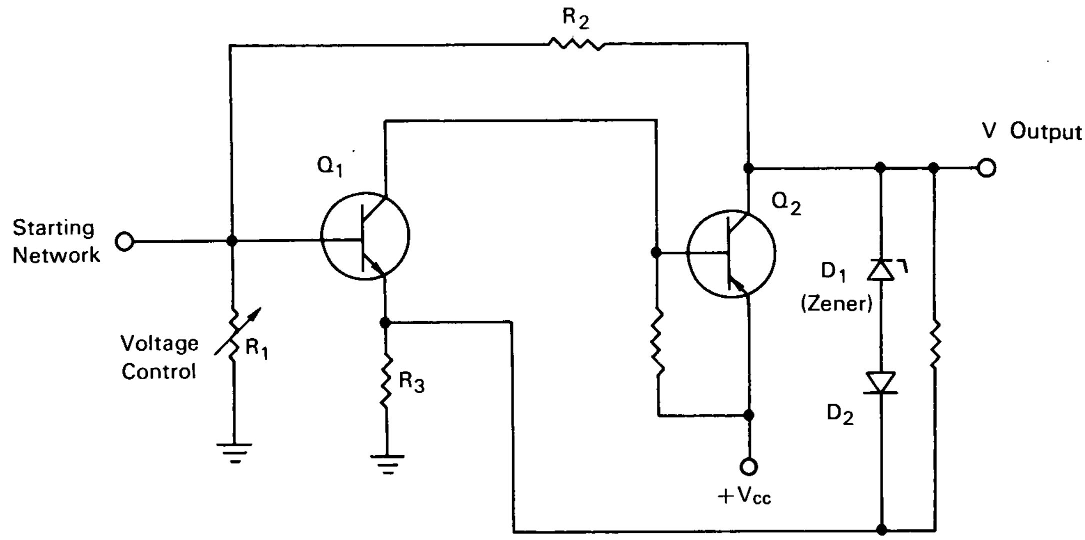
NASA TECH BRIEF

Variable Voltage Supply Uses Zener Diode as Reference



The problem: Zener-diode regulated power supplies are used to provide accurate and stable reference voltages. These power supplies, however, are somewhat limited in their applications, since a zener diode can provide only a single reference voltage. More complex circuitry is required to provide a variable reference supply.

The solution: A simple transistorized circuit, using a zener diode as the reference element, to provide a stable variable reference voltage.

How it's done: As shown on the schematic diagram, zener diode D_1 is used as the reference element for the variable reference voltage supply. Voltage control is provided by a two-stage amplifier, consisting of transistors Q_1 and Q_2. The output voltage can be varied by adjusting resistor R_2, and is equal to

$$V_{out} = V_z(1 + \frac{R_1}{R_2})$$

where V_z is the breakdown voltage of the zener diode.

A positive starting signal applied to the base of Q_1 is required to activate the supply. Since a positive feedback loop between the transistors is incorporated in the circuit, the starting signal can be removed when the zener diode starts to conduct.

Current flow through Q_1 and Q_2 is controlled by the setting of R_1. Increasing the resistance of R_1 increases the current flow through the transistors which, in turn, cause an increased current flow through zener diode $D_1$and resistor R_3. The output voltage appears across the series connection of D_1 and R_3. As the characteristics of the zener diode are fixed, an increased output voltage can be obtained by increasing the voltage (IR drop) across R_3. The voltage rise at

(continued overleaf)

the emitter of Q_1 limits the positive feedback in the circuit and prevents unlimited increase of the output voltage.

Notes:

1. Diode D_2 is included in the circuit to eliminate output voltage dependence upon the emitter-base voltage of Q_1. It may be omitted from the circuit, if desired.
2. The output voltage may be applied to an emitter follower circuit to obtain higher operating currents.
3. This innovation should be of interest to manufacturers of low-voltage power supplies and to researchers in need of variable voltage reference supplies.
4. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland, 20771
   Reference: B65-10097

Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated.

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